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Date: June 9, 2000

Docket No.: 3430-0105P

Assistant Commissioner for Patents
Box PATENT APPLICATION
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of

Inventor(s): MOON, Jeongmin

For: REFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE HAVING AN
AUXILIARY LIGHT SOURCE DEVICE WITH A UNIFORM LIGHT
DISTRIBUTION

Enclosed are:

X A specification consisting of 13 pages

X 4 sheet(s) of formal drawings

X An assignment of the invention

X Certified copy of Priority Document(s)

X Executed Declaration X Original Photocopy

 A verified statement to establish small entity status under 37
CFR 1.9 and 37 CFR 1.27

 Preliminary Amendment

 Information Disclosure Statement, PTO-1449 and reference(s)

JC851 U.S. PTO
09/589881

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Other _____

The filing fee has been calculated as shown below:

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FOR	NO. FILED	NO. EXTRA	RATE FEE		RATE FEE		
BASIC FEE	***** ***** *****	***** ***** *****	***** ***** \$690.00 *****	or	***** ***** \$345.00 *****		
TOTAL CLAIMS	24 - 20 =	4	x18 =\$ 72.00	or	x 9 = \$	0.00	
INDEPENDENT	4 - 3 =	1	x78 =\$ 78.00	or	x 39 = \$	0.00	
MULTIPLE DEPENDENT CLAIM PRESENTED <u>no</u>			+260 = \$ 0.00	or	+130 = \$	0.00	
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X A check in the amount of \$ 880.00 to cover the filing fee and recording fee (if applicable) is enclosed.

_____ Please charge Deposit Account No. 02-2448 in the amount of \$ _____. A triplicate copy of this transmittal form is enclosed.

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Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

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REFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE HAVING AN AUXILIARY LIGHT SOURCE DEVICE WITH A UNIFORM LIGHT DISTRIBUTION

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a reflective liquid crystal display device,
more particularly to a reflective liquid crystal display device having an
auxiliary light source.

Description of Related Art

In general, liquid crystal displays are divided into transmissive
liquid crystal display devices and reflective liquid crystal display devices
according to whether the display uses an internal or outer light source.

While the transmissive liquid crystal display device uses an internal
light source such as a backlight, the reflective liquid crystal display device
uses ambient light and thus is affected by its surroundings. For example,
the brightness of ambient light in an office differs largely from that
outdoors. Also, even in the same location, the brightness of ambient light
depends on the time of day (e.g., noon or dusk). An auxiliary light source
device for the reflective liquid crystal display device is mainly used when
its surroundings get dark.

Fig. 1 shows an auxiliary light source device for the reflective liquid
crystal display device which has a light-directing member. The auxiliary
light source device includes a light source 63, a lamp reflector 65 and a
light-directing member 67. The auxiliary light source device is mounted
on a liquid crystal display panel 61 having a reflector 71.

The light source 63 is located adjacent to an end 67a of the light-
directing member 67, and most of the light source 63 is surrounded by
the lamp reflector 65. The end 67a constitutes a surface through which
the incident light from the light source 63 is emitted. The light-directing
member 67 also has upper and lower surfaces 67b and 67c. A wall-
reflector 69 is mounted along the side walls of the light-directing member
67 other than the emitting surface 67a in order to direct the incident light

the incident light from the light source 63 is emitted. The light-directing member 67 also has upper and lower surfaces 67b and 67c. A wall-reflector 69 is mounted along the side walls of the light-directing member 67 other than the emitting surface 67a in order to direct the incident light toward the liquid crystal display panel 61 disposed under the light-directing member 67.

The emitted light from the light source 63 is directed toward the surface 67a of the light-directing member 67 and to the inside of the light-directing member 67 by the lamp reflector 65. The light-directing member 67 directs the incident light toward the liquid crystal display panel 61. The light transmitted to the liquid crystal display panel 61 is reflected by the reflector 71 and is emitted toward the observer 73.

It should be noted that the auxiliary light source device is mounted on the liquid crystal display panel. Thus, there cannot be a diffusion plate and lens sheet between the liquid crystal display panel and the light-directing member, unlike in a transmissive liquid crystal display device. In order to produce a uniform emitted light distribution, the following four conditions are preferred for the auxiliary light source device of the reflective liquid crystal display device.

First, an incident light from the light source should be directed only toward the liquid crystal display panel and not the observer. Second, the incident light from the light source should be emitted perpendicular to the liquid crystal display panel. Third, the incident light from the light source should be distributed uniformly toward the liquid crystal display panel by the light-directing member. Fourth, the auxiliary light source device should be designed to minimize undesired effects such as a surface reflection and an angle distortion of the incident light from the auxiliary light source by the light-directing member.

Surface light source devices that have a diffusing plate and a lens sheet to increase the brightness are disclosed in U.S. Patent Nos. 5,584,556 and 5,575,549. But these devices are used for the transmissive

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Fig. 1 is a sectional view showing a prior art structure of a reflective liquid crystal display device having an auxiliary light source device;

Fig. 2 is a schematic view illustrating a principle of light refraction in a light directing member having pyramid shaped convex portions;

5 Fig. 3 is a schematic view illustrating a principle of light refraction in light directing member according to an embodiment of the invention;

Fig. 4 is a schematic sectional view illustrating distribution of the convex portions of the light directing member according to the invention;

Fig. 5 is an enlarged view of the "V" portion of Fig. 4, showing a lower portion of the light directing member; and

10 Figs. 6a to 6c are schematic perspective views of the directing member according to the modifications of the invention, where the views are upside down for better understanding.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

15 In order to find an appropriate shape of the light directing member of the auxiliary light source device for the reflective liquid crystal display device, a light directing member having pyramid-shaped convex portions 102 formed on the lower surface thereof and oriented downward is examined, as illustrated in Fig. 2.

20 Since the lower surface 101c of the light-directing member 101 has a large number of pyramid-shaped convex portions 102 in order to increase the brightness, the direction of the incident light from the light source will be altered by these convex portions. Thus, if the size, shape and position of the pyramid-shaped convex portions 102 are appropriately
25 selected, it is possible to produce a relatively uniform emitting light distribution on the liquid crystal display panel (not shown). Further, an arrangement of these convex portions 102 can be varied according to the amount of the emitting light to produce a uniform emitting light distribution.

In order to find the size, shape and position of these convex portions 102 suitable for producing a uniform emitting light distribution, several tests were performed. The lower surface 101c of the light-directing member 101 is a boundary between media 1 and 2. The boundary has boundary surfaces A, B and C, and an angle θ_a exists between boundary surfaces A and C. An angle θ_b exists between boundary surfaces B and C and an angle θ_p exists between the boundary surfaces A and B.

In such a structure with pyramid-shaped convex portions 102, the closer the angle θ_a or the angle θ_b become to 90° , the more perpendicularly the incident light is directed to the liquid crystal display panel. Namely, when the surface A or the surface B becomes perpendicular to the surface C, the angle θ_p between the surfaces A and B becomes zero and the emitting light is directed more perpendicularly toward the liquid crystal display panel.

Thus, in the structure shown in Fig. 2, the angle θ_p between the surfaces A and B is preferably smaller than 10° , but such a structure cannot be manufactured easily.

Fig. 3 shows a more practical shape of the lower surface of the light directing member, which has a main surface C. Surfaces A, B and D together define a convex portion oriented toward the lower reflector (not shown). The angles θ_a and θ_b between the surfaces A and C, and between the surfaces B and C, respectively, approach 90° , and the surface D is substantially parallel to the surface C. This convex portion of the lower surface, which can alter the incident angle of reflected light to an angle close to 90° , is relatively easy to manufacture.

Further, to produce a uniform emitting light distribution toward the liquid crystal display panel (not shown), it necessary to control the amount of the emitted light according to a distance from the light source on the lower surface 301c of the light directing member 301.

In this structure, the surfaces C and D of the lower surface 301c and the upper surface 301b effect a total reflection for incidence angles above a certain value, and thus it is necessary to arrange the convex portions of the lower surface 301c properly.

5 Fig. 4 shows paths of the emitting light in the light-directing member according to an embodiment of the present invention. Light generated by a light source 503 is directed by the lamp reflector 505 to enter a side of light directing member 501. The entering light reflects off of upper surface 502 and lower surface 509, due to the presence of side wall reflector 521. The lower surface 509 has a plurality of convex portions, a lower surface of which is shown as 511. When light strikes a side of one of these convex portions, it is directed downward substantially perpendicular to the reflector 507.

10 In order to distribute, uniformly, the emitting light on the liquid crystal display panel, if it is assumed that all sizes of the convex portions are same, it is required that a distance between adjacent convex portions becomes smaller as the convex portions become more distant from the light source. Alternately, a uniform distribution may be achieved by increasing a size of the convex portions with increasing distance from the light source.

20 Fig. 5 is an enlarged view of the "V" portion of Fig. 4, showing a lower portion of the light directing member. As shown in Fig. 5, it is preferable that an angle 523 between boundary surfaces 515 or 517 and a line perpendicular to a planar (which is a portion of the lower surface of 509 shown in Fig. 4) is about between 0° and 10°. That is, it is desirable that an angle between boundary surfaces 515 or 517 and surface 513 is between 90° and 100°.

25 In addition, it is preferred that a width d2 of the convex portions is less than 100μm, a height 525 of the convex portions is less than 50μm and a distance d1 between two adjacent convex portions is variable

between 10 μ m and 1000 μ m. However, other geometries will become apparent to those skilled in the art with the aid of this specification.

5 Figs. 6a to 6c are perspective views showing several applicable shapes fabricated with reference to above-mentioned values, but illustrate the shapes of the convex portions upside down. That is, the "tops" of the surfaces shown in Figs. 6a-6c are oriented toward the lower reflector (e.g., 507 in Fig. 4).

10 As shown in the figures, the plane surface (corresponding to surface 511 in Fig. 5) of the convex portions can be varied among, e.g., a circular shape 527, a rectangular shape 529 and a bar shape 530. Light from the light source enters the portions of the light directing members shown in Figs. 6a-6c at respective sides 540.

15 As explained above, since the auxiliary light source device according to the invention has a light directing member having a plurality of convex portions on its lower surface, which are arranged closer as they are positioned more distant from the light source, the amount of the light emitted to the liquid crystal display panel is uniformly distributed. Furthermore, since the convex portions have substantially vertical surfaces, the light from the light source can be directed to the panel
20 perpendicularly.

Although preferred embodiments and advantages thereof have been described heretofore, variations and changes are possible by the skilled in the art without departing from the spirit and scope of the invention, which will be indicated by the following claims.

WHAT IS CLAIMED IS:

1. An auxiliary light source device for a reflective liquid crystal display device having a reflector, the auxiliary light source device comprising:
 - a light source; and
 - a light directing member for directing incident light from the light source toward the reflector, the directing member including,
 - a lower surface having a plurality of convex portions extending from the lower surface, each of the convex portions having a substantially planar surface which is substantially parallel to the lower surface.
2. The device according to claim 1, further comprising:
 - a light reflecting member to guide light from the light source into the light directing member.
3. The device according to claim 1, wherein a spacing between the convex portions decreases with increasing distance from the light source.
4. The device according to claim 3, wherein the spacing between adjacent convex portions of the lower surface of the light directing member is in a range of 10 μ m to 1000 μ m.
5. The device according to claim 1, wherein an angle between the lower surface and a surface connecting the planar surface of the convex portion is in a range of 90° to 100° .
6. The device according to claim 1, wherein the planar surface of each convex portion has a circular shape.

7. The device according to claim 1, wherein the planar surface of each convex portion has a rectangular shape.

8. The device according to claim 1, wherein the plane surface of the plurality of convex portions has a bar shape extending perpendicular to a direction of light propagation in the light directing member.

9. The device according to claim 1, wherein a distance between the lower surface and the planar surface of the each convex portion is less than 50 μ m.

10. A reflective liquid crystal display device, comprising:
a display panel including two substrates spaced apart, liquid crystal sandwiched between the two substrates, and a reflector to reflect light through the liquid crystal; and
an auxiliary light source device for supplying light to the display panel, including,

a light source,

a light directing member for directing incident light from the light source toward the display panel, the directing member having a lower surface having a plurality of convex portions, each having a substantially planar surface which is substantially parallel to the lower surface, and

a light reflecting member which guides light from the light source into the light directing member.

11. An auxiliary light source device for a reflective liquid crystal display device having a reflector, the auxiliary light source device comprising:

an upper reflective surface to reflect impinging light above a certain incidence angle;

a lower reflective surface having a plurality of convex portions extending toward the reflector to direct light from the auxiliary light source device to the reflector; and

an entry surface connecting the upper and lower reflective surfaces through which light from a light source enters.

12. The device according to claim 11, wherein each convex portion includes a planar portion and sides connecting the planar portion with the lower reflective surface.

13. The device according to claim 12, wherein an angle between the lower surface and the sides is in a range of 90° to 100° .

14. The device according to claim 13, wherein the planar portion is substantially parallel to the lower surface.

15. The device according to claim 11, wherein a cross section of each convex portion is substantially circular.

16. The device according to claim 11, wherein a cross section of each convex portion is rectangular.

17. The device according to claim 11, wherein each convex portion extends along substantially an entire width of the reflective liquid crystal display device.

18. The device according to claim 11, wherein the plurality of convex portions are spaced along the lower surface to ensure a uniform distribution of light along a length of the device.

19. The device according to claim 18, wherein the plurality of convex portions are spaced closer together with increasing distance from the entry surface.

20. The device according to claim 19, wherein a spacing between adjacent convex portions is in a range of $10\mu\text{m}$ to $1000\mu\text{m}$.

21. An auxiliary light source device for a reflective liquid crystal display device having a reflector, the auxiliary light source device comprising:

a light source extending along a width of the reflector, to emit light along a length of the reflector; and

a light directing device located above the reflector and adjacent to the light source to direct light from the light source to the reflector such that a light distribution of the directed light is substantially uniform along the length of the reflector, and such that the directed light is substantially perpendicular to the reflector.

22. The device according to claim 21, wherein the light directing device includes a plurality of portions extending toward the reflector, a spacing between the portions decreasing along the length of the reflector with increasing distance from the light source.

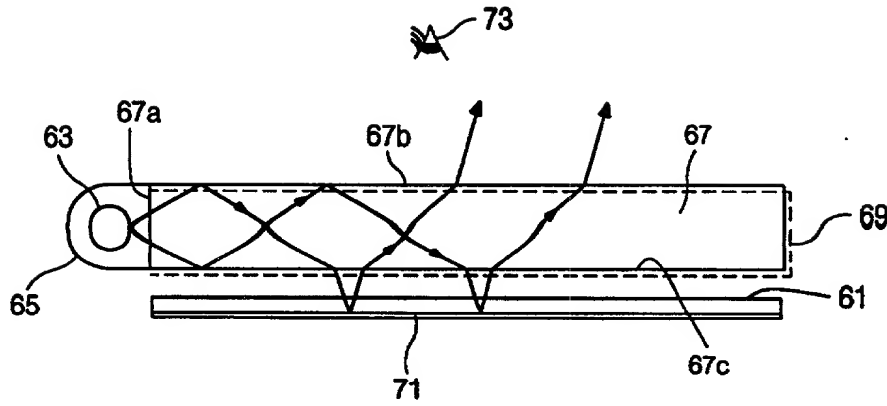
23. The device according to claim 22, wherein the spacing between adjacent portions is in a range of $10\mu\text{m}$ to $1000\mu\text{m}$ and a width of each portion is less than $100\mu\text{m}$.

24. The device according to claim 22, wherein each of the plurality of portions includes a planar surface parallel to a lower surface of the light

directing device and connected to the lower surface by at least one side oriented substantially perpendicular to the lower surface.

ABSTRACT OF THE DISCLOSURE

An auxiliary light source device for a reflective liquid crystal display device includes a light source; a light directing member for directing incident light from the light source toward the reflective liquid crystal display device, the directing member having upper and lower surfaces, the lower surface having a plurality of convex portions protruding from the lower surface of the display device, each of the convex portions having a substantially planar surface at its end, the planar surface of the convex portion being substantially parallel to the lower surface; and a light reflecting member which guides light from the light source into the light directing member.



(RELATED ART)
FIG. 1

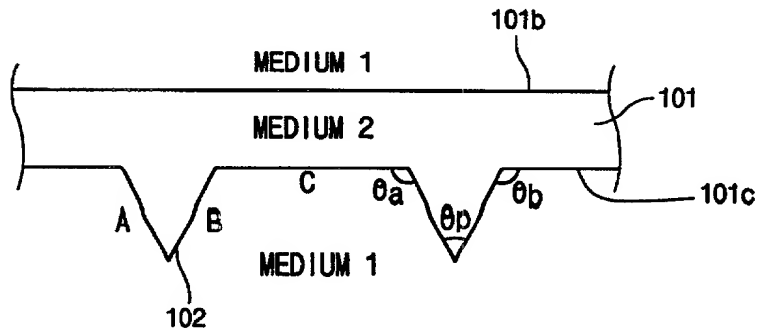


FIG. 2

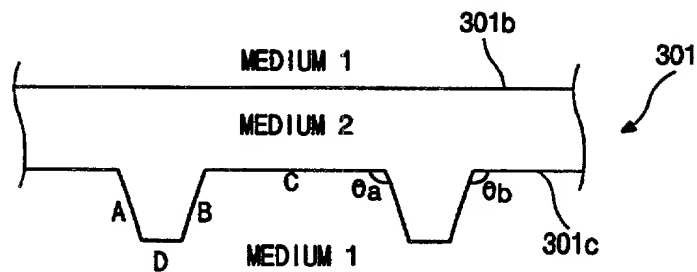


FIG. 3

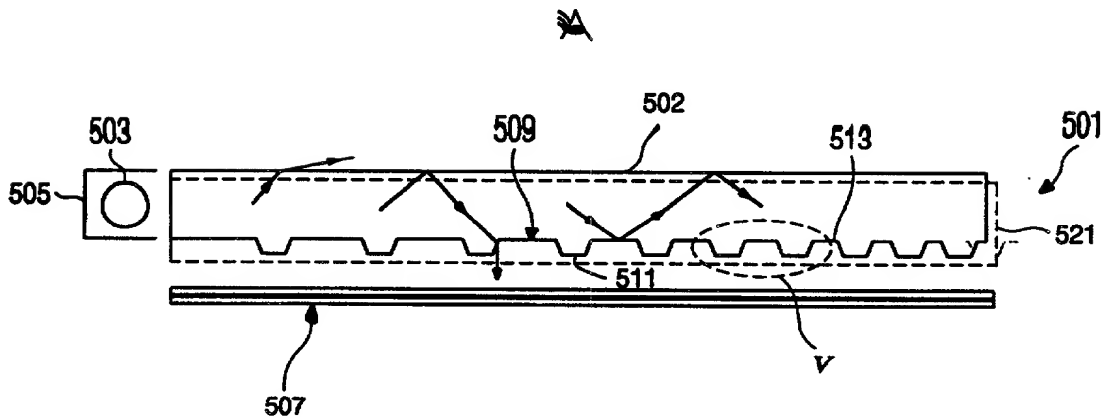


FIG. 4



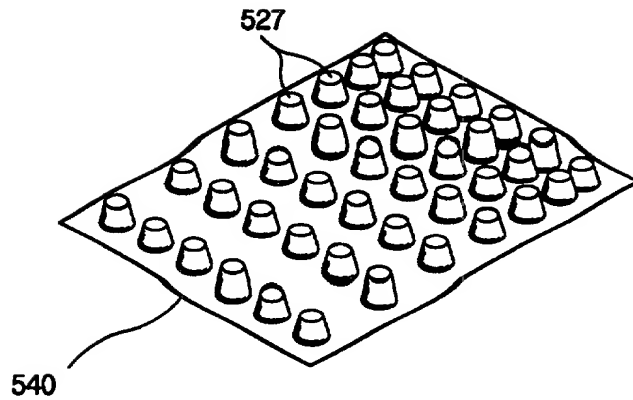


FIG. 6a

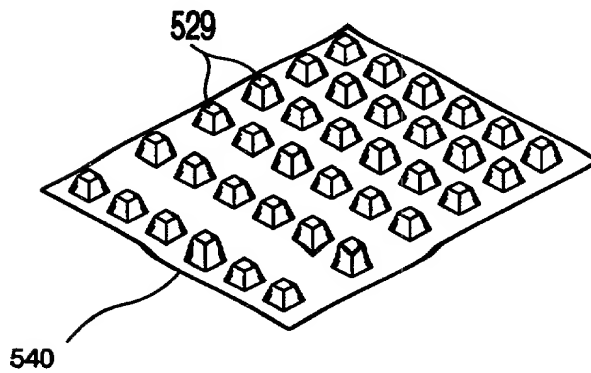


FIG. 6b

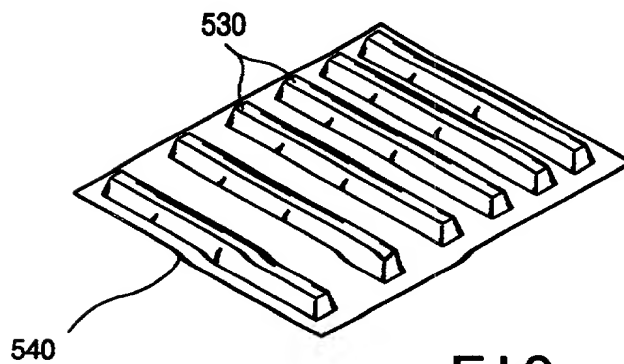


FIG. 6c

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Insert Title:

REFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE HAVING AN AUXILIARY LIGHT SOURCE DEVICE WITH A UNIFORM LIGHT DISTRIBUTION

Fill in Appropriate
Information -
For Use Without
Specification
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I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representative or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority Claimed

1999-21483 (Number)	Republic of Korea (Country)	June 10, 1999 (Month/Day/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
_____ (Number)	_____ (Country)	_____ (Month/Day/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
_____ (Number)	_____ (Country)	_____ (Month/Day/Year Filed)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
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I hereby claim the benefit under Title 35, United States Code, §120 of any United States and/or PCT application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States and/or PCT application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application

Insert Prior U.S.
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_____ (Application Number)	_____ (Filing Date)	_____ (Status - patented, pending, abandoned)
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I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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or Sole Inventor:
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Inventor
Insert Date This
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Full Name of Second
Inventor, if any:
see above

Full Name of Third
Inventor, if any:
see above

Full Name of Fourth
Inventor, if any:
see above

Full Name of Fifth
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GIVEN NAME/FAMILY NAME		INVENTOR'S SIGNATURE	DATE*
Residence (City, State & Country)		CITIZENSHIP	
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